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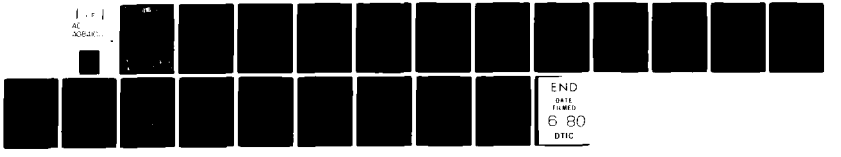

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This report covers work performed on a series of chemical payload launches on sounding rockets, which were launched from Punto Lobos, Peru during October, 1979. These operations included design, fabrication, assembly and launch services for chemical payloads containing trimethyl aluminum (TMA) or titanium tetrachloride ($TiCl_4$) - methanol/water.

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INTRODUCTION

This report covers work performed on a series of chemical payload launches on sounding rockets, which were launched from Punto Lobos, Peru during October, 1979.

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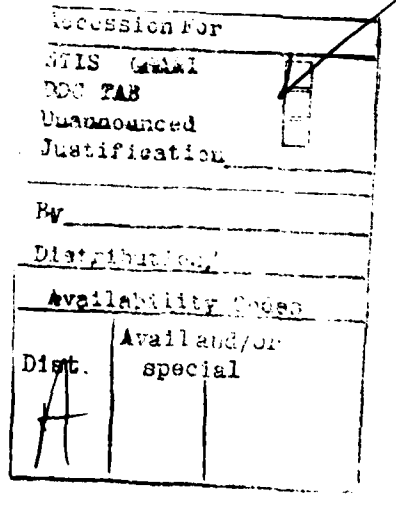


ACKNOWLEDGEMENT

The authors wish to thank Mr. W. Kenneth Vickery of Air Force Geophysics Laboratory for his direction and help on the design, assembly and field service support to the programs reported herein.

TABLE OF CONTENTS

PROGRAM DESCRIPTION

The experiment consists of the local measurement of the turbulent transport properties of the stratosphere by use of a smoke trail produced by the simultaneous release of titanium tetrachloride and a 1:1 mole ratio of methanol and water from a Nike-Nike vehicle. Three payloads were to be launched from Barreira Do Inferna, Sounding Rocket Area, Natal, Brazil. However, the launch site was later changed to Punto Lobos, near Lima, Peru.

PAYLOAD DESCRIPTION

The chemical release payloads use under this program were of a type previously flown, see references. The payload consists of three sections as shown schematically in Figure 1. The forward section consists of a small aluminum nose tip and a conical pressure vessel pressurized to 100 psia. The next section contains the programmer, batteries, explosive valves and appropriate liquid and gas plumbing. The third section is a cylindrical tank within a tank for the liquid chemicals, 135 pounds of titanium tetrachloride in the inner tank and 118 pounds of 36 wt. % water - 64 wt. % methanol in the outer tank. A Nike adaptor ring is attached to the chemical tank. Figure 2 shows the flow diagram and plumbing. A description of the chemicals used is included in the appendix.

PROGRAMMER DESCRIPTION

The payload uses a type 12-309B programmer which is shown schematically in Figure 3. The timer module for the programmer is shown schematically in Figure 4. Table I lists the programmer timing cycle for the trail release.

PAYLOAD MAKE-UP

Tankage for three payloads was received from AFGL in January of 1979. Payload build-up consisted of careful examination and pressure checking of all tankage. The tanks were then fit checked to verify that all parts mated properly. At that time, it was determined that minor changes would have to be made in the Nike adaptor ring. These changes were made at Germantown Laboratories: the pieces did not have to be returned to AFGL. The tankage was then painted to protect the sheet metal surfaces. The cone and cylindrical tanks were mated, and plumbing build-up was accomplished. The plumbing consists of two explosively activated valves, two electrically activated valves, and a reach rod activated handvalve, along with dip tubes, fittings and interconnecting tubing (see Figure 2). After the plumbing was installed, the entire payload system was pressure checked and the solenoid valves activated to check performance.

Programmer preparation consisted of mechanical timer preparation, electronic timer preparation, set up of the programmer bracket, and assembly of the battery pack.

LAUNCH OPERATIONS

The three payloads and accompanying equipment were shipped via USAF air transport to Lima, Peru, and then to the launch site by Peruvian Air Force personnel. The payloads were reassembled and checked. Whenever practical, filling operations took place out of doors or with an exhaust line leading outside because of the smoke problem with titanium tetrachloride. The alcohol-water system presented no problem in filling. After the programmer was checked and installed, the payload was taken to the launch area and mated to the Nike. The pyaload was pressurized on the launch rail as part of the flight checkout procedures. Table II lists the payload parameters for the three units launched at Punto Lobos, Peru. All three flights were successful, releasing the chemicals at the proper times as noted in Table I.

BATTERY CONSIDERATIONS

The use of Yardly HR-DC10 silver cells may present a problem in the future because of cost and availability. The use of Eagle-Picher "carefree" type batteries has been investigated. Two type CF12V1, 12 volt, 1 ampere hour cells were used in the evaluation. This battery pack is approximately the same size as the present unit consisting of 18 HR-DC10 silver cells. A breadboard programmer consisting of a timer module, the CF12V1 battery pack and a 28V solenoid valve was placed in the 500 CF vacuum tank. The tank was evacuated to an altitude of 45 Km and the programmer activated. The valve and timer operated correctly with no electrolyte leakage from the battery pack. The battery pack was in the vacuum for a period of two hours.

Subsequent use of the battery pack showed adequate capacity to operate two 28V solenoids for a minimum of 100 cycles. The use of this type battery for future payload programmers is recommended.

TABLE I

PROGRAMMER TIMING - TRAIL RELEASE

NIKE-NIKE SMOKE SYSTEM

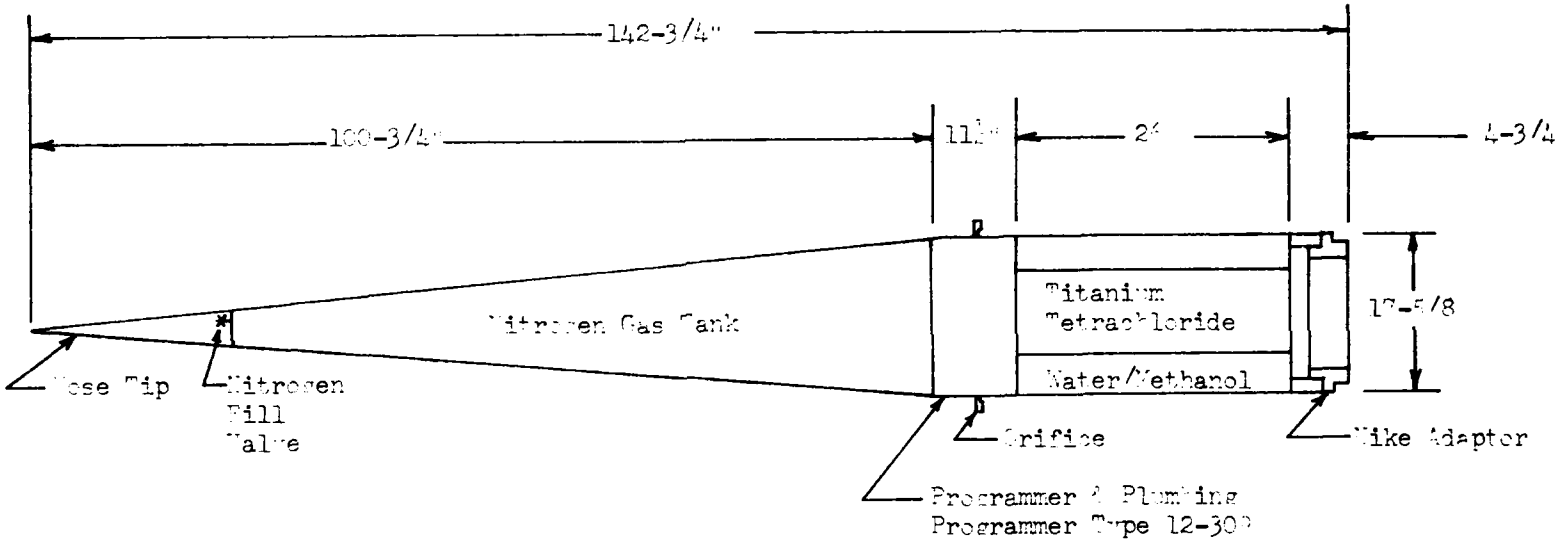
Titanium Tetrachloride Orifice	0.303 inch
Tank Pressure	100 psia
Flow Rate	2.28 lbs/sec.
Methanol/Water Orifice	0.335 inch
Tank Pressure	100 psia
Flow Rate	2.00 lbs/sec.

Trail No.	Start Second	End Second
1	30	36
2	40	46
3	50	56
4	60	66
5	70	76
6	80	86
7	90	96
8	105	120

Programmer Type 12-309

TABLE II
PUNTO LOBOS, PERU
PAYLOAD PARAMETERS, NIKE-NIKE SMOKE SYSTEM

Payload No.	01	02	03
Vehicle	Nike-Nike	Nike-Nike	Nike-Nike
CH_3OH/H_2O Aft. Tank			
Wt. Chem. (lbs.)	118	118	118
Orifice (in.)	0.335	0.335	0.335
$TiCl_4$ Fwd. Tank			
Wt. Chem. (Lbs.)	135	135	135
Orifice (in.)	0.335	0.335	0.335
Nose Cone			
Pressure (PSIA)	100	100	100
Total Payload Wt. (lbs.)	549	549	549
CG, in. From Nike Joint	25	25	25
Launch Date	Oct. 23, 1970	Oct. 24, 1979	Oct. 29, 1979



Payload Weight - [illegible] Pounds

Payload Chemicals:

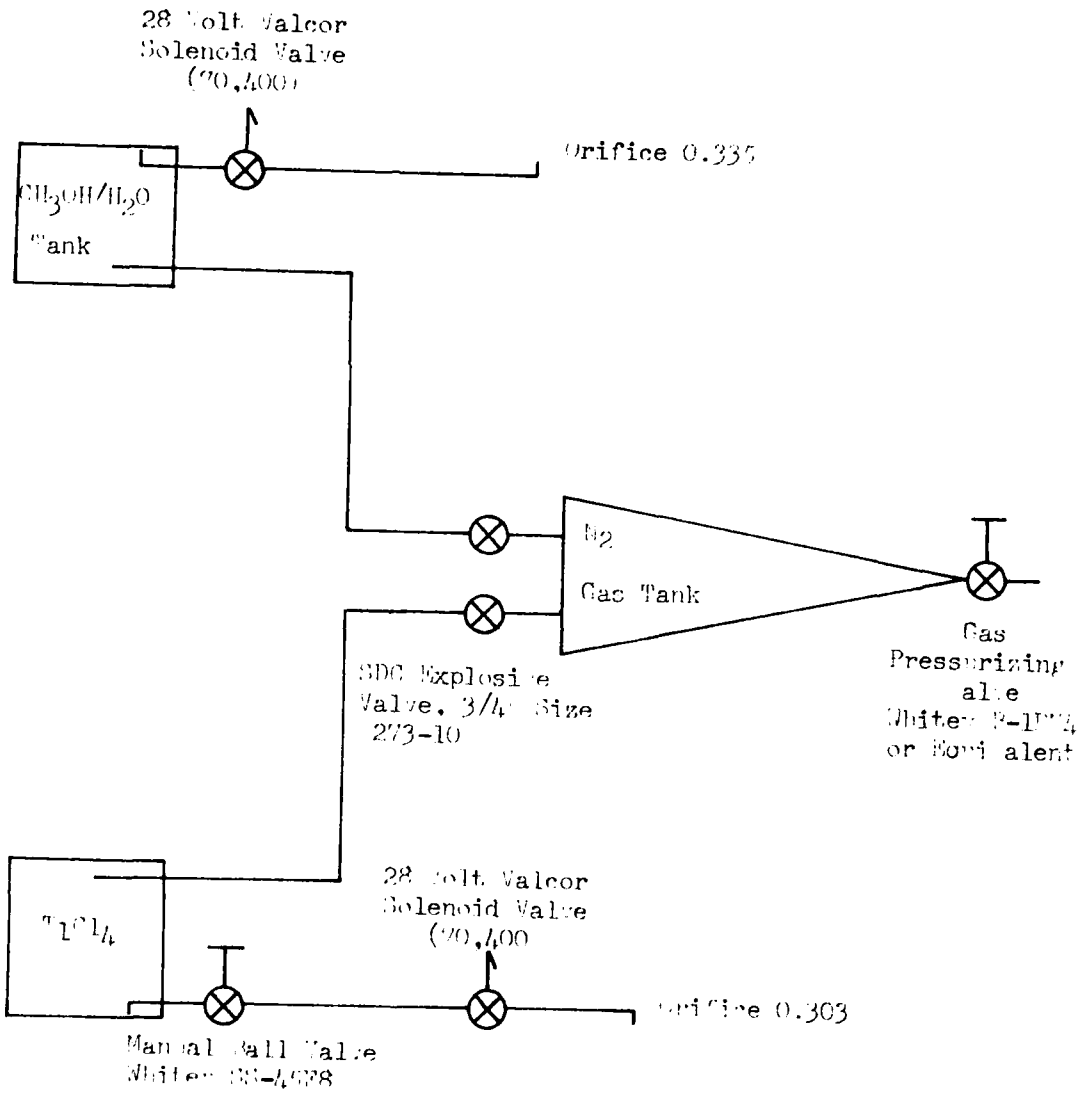
Titanium Tetrachloride - 13[illegible] Pounds
3[illegible] Wt. % Water/[illegible] Wt. % Methanol - 11[illegible] Pounds

[illegible] PAYLOAD

FIGURE 1

FIGURE 2

FLOW DIAGRAM



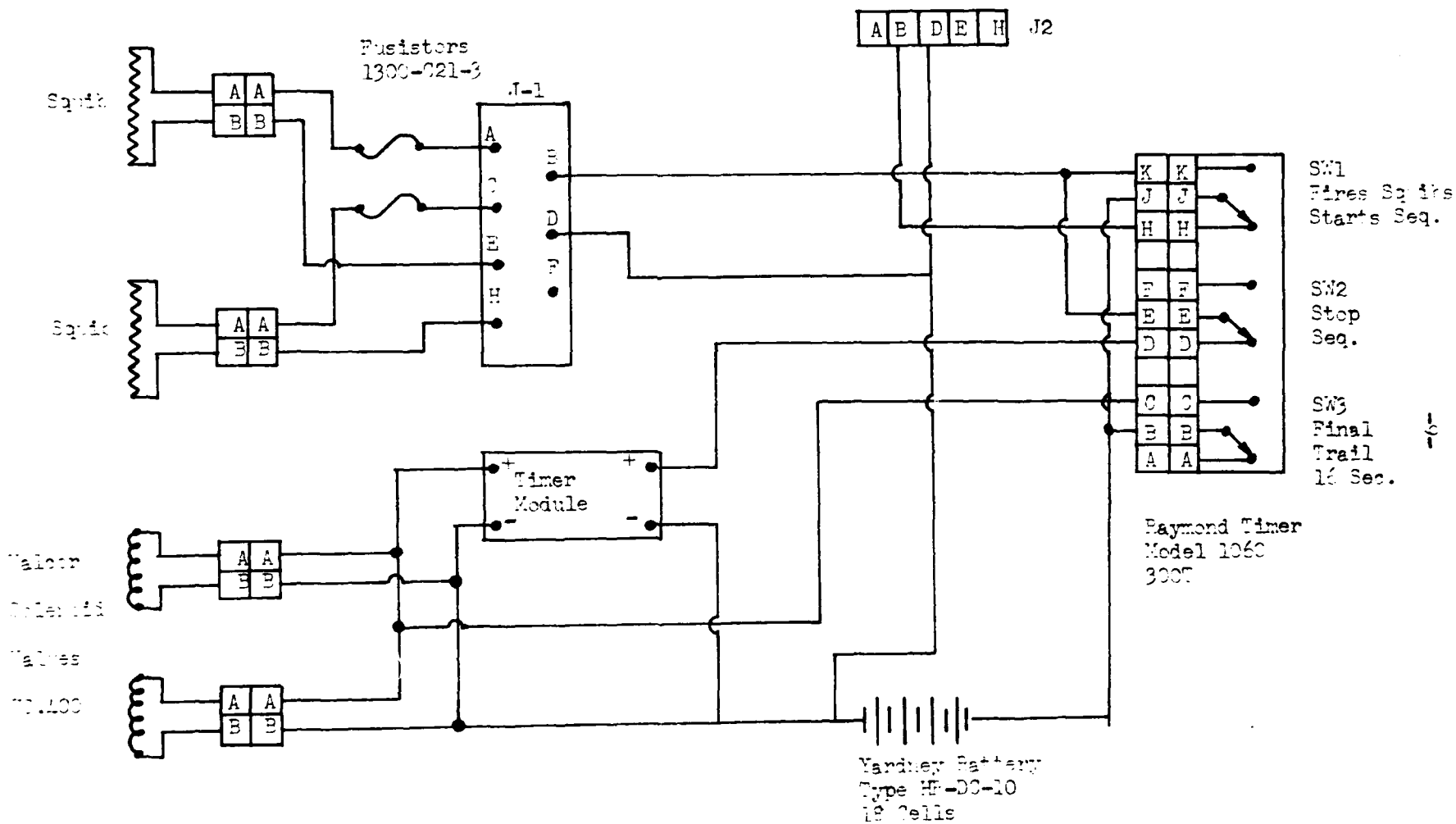
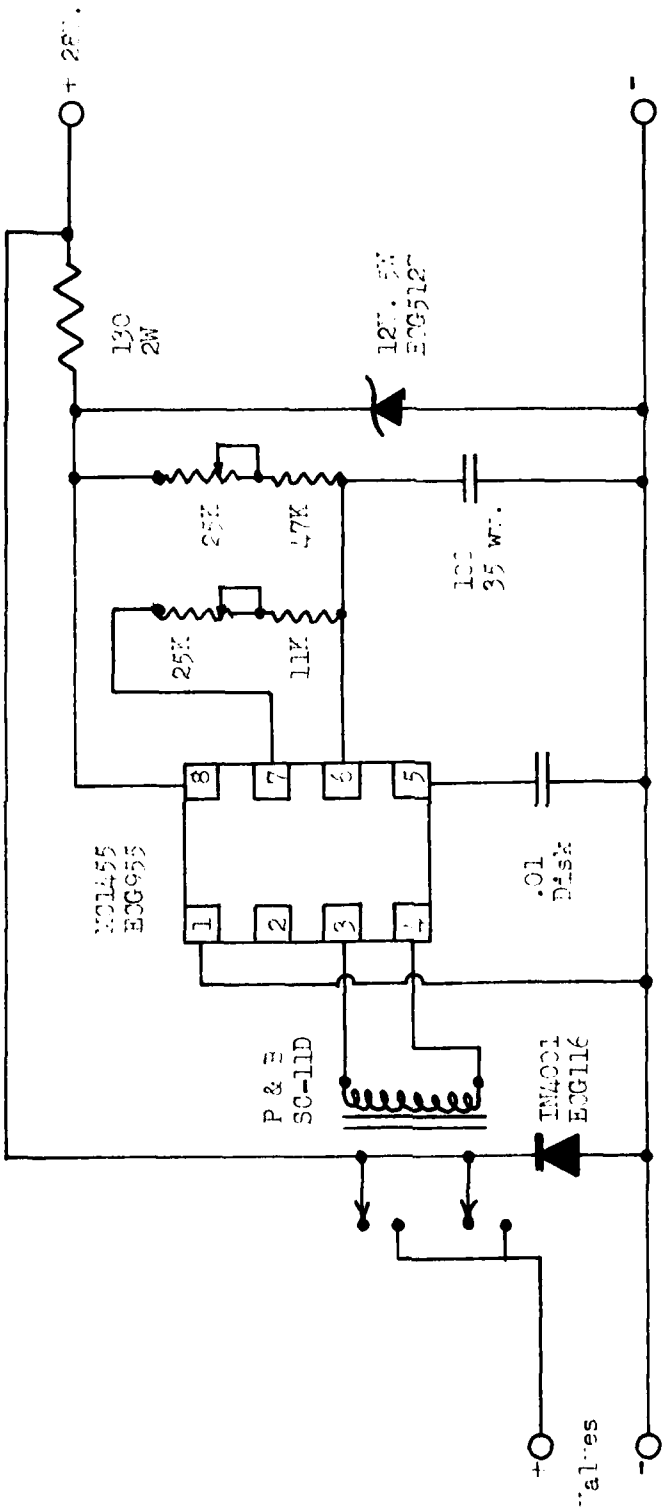

Fusistors
1300-021-3
J-1
A B D E H J2
Squib
Squib
Timer
Module
SW1
Fires Squibs
Starts Seq.
SW2
Stop
Seq.
SW3
Final
Trail
16 Sec.
Raymond Timer
Model 1060
300T
Yardney Battery
Type HF-DC-10
12 Cells

FIGURE 3


+ 28V
-
120
2W
25K
47K
25K
11K
100
35 WV.
.01
P & B
SC-11D
1N4001
EG116
+
-

APPENDIX

FM-Titanium Tetrachloride

Action on Metals	Corrosive: no action on steel if FM is dry: vigorous action if FM is moist, FM smoke is corrosive.
Boiling Point	275°F.
Chemical Name	Titanium Tetrachloride
Chemical Storage Group	B
Decomposition Temperature	None Below Boiling Point of 275°F.
Decontaminants	Any Alkali in Solid or Solution Form.
Formula	$TiCl_4$
Freezing Point	Minus 22°F.
Hydrolysis Products	Solid TiOCl and HCl: also $Ti(OH)_4$ if sufficient water is present.
Munitions Markings	FM SMOKE in black on light green background.
Odor	Acrid
Rate of Action	Rapid
Rate of Hydrolysis	Reacts immediately with water or water vapor.
Specific Gravity	1.7 at 68°F.
Stability in Storage	Stable in steel containers if FM is dry.

DESCRIPTION

FM is a liquid compound, titanium tetrachloride, which can be atomized by detonation or by spraying into the air. When it is thus atomized, it hydrolizes and the smoke soon becomes a composition of solid and liquid particles.

Nitrogen is used with FM to produce pressure. At times a small percentage of other chemicals is added to the compound. The smoke mixture is corrosive and is a colorless to light yellow liquid that weighs 14 lbs. per gallon.

FM reacts vigorously with the moisture in the air to form a dense, white, persistent smoke cloud of finely divided titanium hydrate particles and mist of hydrochloric acid vapor. The formation of the solid particles sometimes clogs spraying apparatus. For this reason, it has been replaced to a large extent by FS.

When FM is in a dry state, it has no reaction on steel. If FM is moist, however, it will have a strong corrosive effect on steel.

FM smoke increases in density as the humidity increases. Although a good smoke is produced with average humidity, it tends to dissipate more rapidly than when the humidity is above average.

While FM smoke is considered, under normal conditions, as nontoxic, the liquid burns the skin like a strong acit. The smoke is mildly irritating to the nose and throat at the concentrations found in a smoke cloud, but a protective mask is only required for a heavy concentration.

Detection - heavy colorless liquid having a mildly acrid or pungent odor. Readily detected by large quantity of smoke produced when it leaks from a container.

DECONTAMINATION

Observe the following precautions when handling FM in bulk quantities:

1. Personnel handling FM drums or munitions must wear protective gloves and boots.

2. Personnel handling FM during filling operations, or at other times when this agent could splash on them, should wear goggles, protective aprons or clothing, gloves and boots.

3. It is preferable for personnel operating in an FM smoke cloud to wear protective masks. It is mandatory that masks be worn wher the cloud is in a confined space with high concentrations of FM smoke.

4. When FM is spilled, it must be destroyed by repeated dousing with water. Care must be taken to avoid injury from droplets that are likely to be scattered by the violent reaction of FM with water. For this reason, a small amount of water should never be allowed to contact a large amount of FM mixture. If any liquid FM comes into contact with any part of the body, it shouls be immediately wiped off and the body washed with an abundance of water, then rewashed with a weak solution of bicarbonate of soda or ammonia in water. Contaminated clothing should be removed before washing the body with water or serious burns are likely to result.

STOWAGE

FM is stowed is 55-gallon steel drums. It is stable inside these drums, where it is concentrated, but fumes leaking out past the bunghole plugs will react with moisture in the air to form a corrosive mist that will eat away the outside of the drums.

The drums should be painted on the outside with an acid and weatherproof paint. They should be stowed in well ventilated magazines ashore. (outdoor stowage is permissible if the outer surfaces of the drums are kept well painted). They should be kept on racks at least 4 to 6 inches off the ground or the floor, as FM vapors are heavy and hug the ground.

Aboard ship the drums should be stowed topside only, but they must be protected from the sun and from salt water spray and constantly inspected for signs of corrosion, leakage and paint deterioration.

The drums should be vented when they have been subjected to direct sunlight or abnormally high temperatures for a protracted period of time. They must also be vented when bulging because of pressure (this calls for extreme caution on the part of personnel doing the venting), or when the drums are to be opened. When venting is necessary, the drums to be vented

should be removed from the place of stowage to prevent contamination of the remaining drums. When it is desired to open FM drums, they should be removed far enough from the place of stowage that the corrosive vapors released when the plug is removed will not be able to contaminate other drums.

When a drum begins to leak badly, the FM should be transferred to any empty nonleaking drum. If no suitable empty drums are available, the leaking drums should be disposed of in order to avoid corroding other drums.

FIRE FIGHTING

If a fire involves or threatens buildings in which FM is sotred, all persons within the danger zone shall be notified to vacate until all danger is passed. Fires in magazines shall not be fought. Since a fire involving chemical ammunition is dangerous to the inhabitants of the vicinity, special precautions must be taken to present fires in areas where this chemical ammunition is stored. FM is non-flammable, but may cause fires if spilled on flammable material. This is especially true under damp conditions.

36% WATER - 64% METHANOL (WM)

Composition	36% H_2O - 64% Methanol by Weight
Specific Gravity at 68°F.	.8834
Freezing Point	Below -50°F.
Stability in Storage	Excellent

This mixture is similar to "anti-freeze" solutions in auto radiators, however, the methanol percentage is higher. The mixture is toxic if ingested and fumes can be an irritant if inhaled over a long period. The mixture of water with methanol will reduce the vapor pressure of the methanol and hence the hazard due to inhalation.

Pure methanol is extremely flammable. When mixed with water at these percentages, the mixture can be ignited with some difficulty, the alcohol will boil out of solution and burn with the usual blue flame. In general, the mixture poses no special handling problems, especially with the small quantities being used (less than 5 gallons).